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Semisoft Skimmilk Cheese. Pilot Plant Procedure

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Abstract

Adaptation of laboratory procedures to pilot plant manufacture of semisoft skimmilk cheese is described. The manufacturing time schedule including acidities as well as pH ranges during curing is given. Results show that good natural lowfat cheese with acceptable body, texture, and flavor can be made on a pilot plant scale and commercial adaptation can be accomplished.

The laboratory procedure developed by Hargrove et al. (2) for making a ripened low-fat cheese indicated the feasibility of manufacturing a semisoft skimmilk cheese. However, before successful industrial application, it was essential to expand the procedure to a pilot plant scale. Results of the laboratory research involving over 1,200 lots of experimental cheese indicated that many different combinations of manufacturing procedures may be used to produce an acceptable cheese (3). While satisfactory cheese was manufactured, variations in quality were evident.

The laboratory procedures, when used on a pilot plant scale, presented many new problems in controlling moisture, salt, and rate of acid production during and after manufacture. Several modifications in the procedure were required in the transition to the pilot plant scale. Changes from the experimental procedures to the developed pilot plant manufacturing method are described.

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Materials and Methods [1]

Equipment. The preliminary phase of the pilot plant study was a hand operation conducted in 544 kg capacity Cottage cheese vats, using 227 kg of milk per vat. The curd from each vat filled one conventional 18.1 kg block style hoop. The filled hoops were pressed with 22.7 kg weights in a vacuum chamber, and then pressed in a conventional hydraulic press for one hour followed by overnight holding at 5 to 20 C before wrapping.

The final work phase involved the use of 1,633 kg of milk in an 1,814 kg capacity stainless steel vat equipped with an agitator, paddles, and forkers. Eight hoops of cheese resulting from this operation were handled similarly to the previously described procedure.

[1] Mention of brand or firm names does not constitute an endorsement by the Department of Agriculture over others of a similar nature not mentioned.

Milk processing. The milk was obtained from the dairy herd maintained by the Dairy Husbandry Research Branch, Beltsville, Maryland. Whole milk, one or two days old was cold-separated, fortified with low-heat pretested nonfat dry milk, standardized with specially treated whole milk to the desired fat content, pasteurized in a high-temperature short-time unit at 73.3 C for 16 sec, and cooled.

Cultures. The starters were multiple strain cultures in lyophilized form obtained from commercial starter laboratories. They were reconstituted and incubated according to the supplier's instructions. Starter strains were carried separately and mixed in bulk starter making.

Chemical analysis. The cheese was analyzed 20 hr after manufacture for milk fat, salt, and moisture before wrapping. Milk fat and moisture were determined by the Mojonnier methods and salt by the AOAC method (1).

Detailed Procedures

Table 1 shows the time schedule, acidities, pH, and temperatures during the manufacture of low-fat cheese. Manufacturing steps follow:

Preparing the rancid flavored whole milk. Fresh raw whole milk was standardized to 4.0% milk fat, homogenized at 32.2 C at 105 kg/cm^2 single stage, heated to 40.5 C, and held for 30 min to develop lipolysis. Further lipolytic activity was stopped by heating to 68.3 C for 5 min. The milk was then cooled to 4.4 C and held until needed.

Standardization and fortification of the low-fat milk. The rancid whole milk and low-heat pretested nonfat dry milk were circulated and blended with the fresh skimmilk to produce 0.6% milk fat and 11% total solids. This mixture was pasteurized at 73.3 C for 16 sec and cooled to 32.2 C, and weighed into the cheese vat.

Preparing the starter. Mother starters carried in sterile mlk and bulk starter prepared with steamed skimmilk were prepared in the conventional manner of 1% inoculation with incubation at 21.1 C for 17 to 18 hr.

Adding starter and ripening. After adding 2 to 3% starter, the milk was ripened for 60 min at 32.2 C. During this period the acidity increased from 0.20 to 0.23 and the pH dropped from 6.6 to 6.45.

Adding color and rennet. Cheese color at the rate of 6 ml per 454 kg of milk was diluted with water and stirred into the milk. Single strength rennet at the rate of 80 ml/454 kg of milk was diluted with water and added to the 32.2 C milk and mixed well for three minutes.

Cutting the curd. Thirty minutes after adding color and rennet, the coagulated milk was cut with 1.58-cm curd knives. Agitation was delayed until the curd was covered with whey. Care was taken in stirring to avoid shattering the curd particles with the rake or agitator paddles. Whey acidity at cutting approximated 0.145, pH 6.4.

Cooking the curd. Fifteen minutes after cutting, the curd was cooked in a manner similar to Cheddar curd. Agitated curd and whey were slowly heated in 30 min to 37.7 C. Significant shrinkage of the particles was quite noticeable as the curd formed. All parts of the vat were stirred to prevent curd matting.

Draining the whey and cooling the curd. When pH of the whey reached 6.1 to 6.2, the curd was pushed back in the vat and the whey drained. Gentle stirring of the curd during draining aided in the removal of whey and kept the curd from matting. When the vat was well drained, cold water (3 to 5 C) was added to lower the curd temperature to 21 C. This operation completely inhibited matting, removed free whey from the curd, and slowed culture growth that helped control acid development. When the mixture of curd and water had been held at 21 C for 5 min, the water was drained, and the curd trenched, stirred and retrenched every 5 min for 15 min.

Salting. Salt was slowly added to the curd at the rate of 1.9 kg/454 kg of milk and mixed in well with mechanical forkers. The salted curd was then trenched, stirred and retrenched every 5 min for 15 min.

Hooping. The curd was placed in hoops 15 min after salting. An extra hoop was temporarily required to accommodate more than 27 kg of curd. The paper bandage was folded over the curd, a 27.3 by 34.9-cm press plate was inserted and a 22.7-kg press weight applied. When the curd was pressed below the extra hoop the press plate and ring were removed and a hoop cover was added.

Vacuum pressing. The weighted hoops were subjected to a vacuum of 125 mm of mercury and held for 10 min, then slowly released.

Pressing. The hoops of cheese were removed from the vacuum chamber and pressed in a conventional hydraulic cheese press using 0.7 kg/cm^2 water pressure for one to two hours. Cheese blocks were removed from the hoops and paper bandage pulled free (dressed) to insure a smooth surface on the rindless cheese during overnight pressing.

Overnight pressing. After dressing, the hooped cheeses were placed in a 5 to 22 C room and pressed with the equivalent of 22.7 kg per hoop. The pressing room temperature used was determined by the pH of the cheese at hooping.

Packaging. Following overnight pressing the pH was usually 5.65 to 5.85. At this pH the paper bandage was removed and the cheese was wrapped in Parakote, pressed, and sealed in the heated hoops. The cheese was packed in fiberboard boxes and stored in either a 4- or 10-C room until pH of the cheeses was approximately 5.7. Cheeses with an overnight pH of 5.5 to 5.7 were immediately placed at curing temperature.

Curing. The boxed cheese at about pH 5.7 was stored at −1C to +1 C for 2 to 3 months.

Results and Discussion

Low-fat cheese develops its flavor in 6 to 12 weeks primarily from the lipolysis of the homogenized fat. The typical rancid flavor is sweet and similar to young Italian cheese. Its

TABLE 1. Time schedule for making semisoft skimmilk cheese.

Operation	Time	Temp	TA[a]	pH	Comments
		(C)			
Add starter	8:00 AM	32.2	0.21[b]	6.60[b]	2 to 3% starter
Add rennet	9:00	32.2	0.235	6.45	
Cut curd	9:30	32.2	0.15[c]	6.40[c]	1.58-cm curd knives. Stir after whey covers curd. Curd settles quickly. Agitate all curd particles.
Steam on	9:45				
Steam off	10:15	37.8	0.16	6.30	
				6.20	Prevent curd from matting. Low fat curd settles more readily than Cheddar curd.
Drain whey	11:00	37.8	0.17	6.20	
				6.10	
Add cold water	11:15	21.1			Cold water 3 to 5 C. Prevent curd matting.
Drain cold water	11:20	21.1			Stir and drain curd several times.
Salting	11:35				Salt content of finished cheese 2.2 to 2.5%.
Hooping	11:50				25.5-kg curd is required for 18-kg cheese. Use 22.7-kg weight on cheese hoops in chamber.
In vacuum chamber	12:05 PM				
Out vacuum chamber	12:35				
Hydraulic press	12:40			5.90[d]	
				6.00	
Dress	1:40				Cheese must be dressed to prevent uneven surface pressing.
In 0 to 20 C box	1:50				Cheese remains in hoops under 22.7-kg weights overnight.
Wrap Parakote				5.7	
Next AM	8:00 AM	6-8		5.8	
Store + 0 C box				5.6	
2 weeks				5.7	
4 weeks				5.6	
6 to 8 weeks				5.5	
Packaging 6 to 12 weeks				5.5	
				5.7	

[a] Titratable acidity.
[b] Milk.
[c] Whey.
[d] Curd.

body varies from slightly curdy to smooth and resilient depending on its age and moisture content. Cheeses containing more than 57% moisture have very few mechanical openings while cheeses with less than 54% moisture have numerous mechanical openings.

During manufacture the large cut pieces of curd expel whey rapidly and shrink in size, similar to Cottage cheese curd after washing. The acid producing organisms in Cottage curd are completely inhibited by high cooking temperatures and low pH. In this low-fat cheese the organisms are not destroyed, but are controlled by the amount of starter used, the cold water for washing curd, the amount of salt, and the cold storage temperatures. Lack of control of any one of these factors would provide conditions for the growth of acid producing organisms, resulting in poor quality cheese. Strict control of acid development and pH is an absolute necessity during manufacture and storage. Insufficient acid development at 20 hr (pH above 6.0) resulted in fruity fermented cheese while too much acid (pH below 5.5) resulted in acid, bitter cheese.

During the preliminary research of making low-fat cheese on a pilot plant scale, the resulting 18.1-kg blocks of cheese became very acid and bitter in storage. This was due, in part, to the slow cooling rate of the large blocks of cheese to below the growth temperatures of the lactic acid producing organisms. Changes were made in the laboratory procedure to control the acid developed by reducing the amount of starter from 6 to 2%; the cooking temperature from 43.3 to 37.8 C; the temperature of cooling the curd from 26.6 to 21.1 C; and the cheese curing temperature from 4.4 C to −1 to +1 C.

Control of the acid in the finished cheese also depends on the composition, particularly the ratio of salt to moisture. Low moisture cheese (52 to 54%) containing high salt, 2.6 to 2.8% (equal to 5.0 to 5.2% brine) delayed body breakdown for months without any appreciable flavor except salt. High moisture cheese (58-59%) containing low salt 1.8 to 2.0% (equal to 3.1 to 3.3% brine) resulted in bitter cheese. Cheese containing 55 to 56% moisture and 2.3 to 2.5% salt (4.1 to 4.4% brine) and cured at 0 C, produced satisfactory breakdown and flavor within 2 to 3 months. Cheeses containing as much as 59% moisture and 2.25% salt (3.8% brine) cured at 0 C for 8 to 10 weeks were of good quality at pH 5.6. Moisture, salt content, and quality varied with acid production. The percentage of salt in the moisture (% brine) in the better quality cheese varied from 3.75 to 4.5%. The brine percentage in these examples ranged from 3.05 to 5.4%.

The pH of the cheese during overnight pressing and storage was maintained by strict control over cheese temperature. For example, if pH of the cheese at the press was 5.9, the pH at packaging after overnight pressing at 21 C would approximate pH 5.5; at 10 C pH 5.6; at 4.4 C pH 5.7; and at 0 C would approximate pH 5.8.

Cheeses pressed at 10 and 21 C, because of their internal temperature, continued to develop acid after they were placed at 0 C and when cured were usually acid cheese. Cheeses pressed at 0 and 4.4 C, because of their low internal temperature, developed very little additional acid when placed at 0 C and when cured were of better quality than those pressed at higher temperatures.

Changes in the pH of the cheese during two months storage at −1 to +1 C were usually minor and insignificant. Changes in flavor did occur at these storage temperatures especially if the pH was high, i.e., pH 5.75 or above, often resulting in fruity flavors.

Results show that good natural low-fat cheese with acceptable body, texture, and flavor can be made on a pilot plant scale and is commercially adaptable.

To determine if consumers would purchase this cheese, a 12-week test market study was carried out jointly with the U.S. Department of Agriculture Economic Research Service in four supermarket food stores in the Washington, D.C., Metropolitan area. The cheese, named EUDA[2]-Eastern Utilization, Department of Agriculture, was sold in film wrapped random sized wedges of 255 to 520 g. Results of the market test indicated that this cheese has potential as a new commercial product. Complete details of the marketing study are being published elsewhere by the Economic Research Service.

[2] This cheese was manufactured under a nonexisting standard of identity.

References

(1) Association of Official Agricultural Chemists. 1960. Official and Tentative Methods of Analysis. 9th Ed. Washington, D.C.

(2) Hargrove, R. E., F. E. McDonough, and R. P. Tittsler. 1966. New type of ripened low-fat cheese. J. Dairy Sci., 49: 796.

(3) Hargrove, R. E., F. E. McDonough, and R. P. Tittsler. 1967. Factors affecting characteristics, composition and quality of skimmilk cheese. J. Dairy Sci., 50: 160.